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Stochastic performances estimate of a universal and flexible power management system for the future European electricity network

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Extended abstract

This paper presents the final results of the activities carried out by the authors to estimate the availability performances of an innovative modular power conversion architecture, developed within the UNIFLEX-PM (Universal and Flexible Power Management) EU project.

The project is a European Project of the 6th Framework Programme co-financed in the sustainable energy systems call, and it proposes an innovative modular power converter architecture that can satisfy the requirements of Future European Electricity Network. The UNIFLEX-PM system is characterised by a three-phase architecture, adopting multi-level converters (IGBT technology based), which allows a bidirectional power flow.

The proposed solution is based on a DC/DC isolation stage, characterized by a symmetrical configuration: there are four conversion stages, two by two equal. In particular, as depicted in Fig.1, the following macro-blocks are present in each level:

- an input macro block consisting of AC/DC and DC/AC conversion units with interposed a DC link;
- a Medium Frequency (MF) transformer for isolation purposes;
- an output macro block consisting once again of AC/DC and DC/AC conversion units with interposed a DC link.

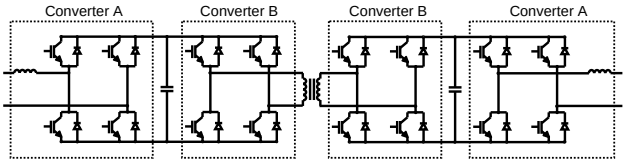

Fig. 1. UNIFLEX-PM architecture (DC/DC isolation stage) – one level

The performed study also addresses the analysis of the effects on system stochastic performances deriving from basic components wear out phenomena, and the ones deriving from the adoption of different redundancy strategies and maintenance policies. The UNIFLEX-PM architecture represents an innovative solution for power management in the distribution networks, thus the reliability and availability studies have been focused on obtaining basic figures useful to define the effectiveness of the proposed solution through comparison with a power converter architecture already used for building commercial products and assumed as the reference case.

As far as the paper contents are concerned, the first section deals with a brief description of the UNIFLEX-PM and reference case architectures. Once identified the basic components and their reliability characteristics, the general assumptions taken into account for the dependability analysis for both UNIFLEX-PM and the reference case are then presented. The last section of the paper deals with the availability estimate process, carried out through a dedicated software tool developed by the authors and based on the Monte Carlo method: the availability results for UNIFLEX-PM and for the reference case are reported and discussed.